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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/657,505	09/08/2003	Chii-Ming Wu	TS01-1247	9336
42717	7590	09/27/2006	EXAMINER	
HAYNES AND BOONE, LLP 901 MAIN STREET, SUITE 3100 DALLAS, TX 75202			GEYER, SCOTT B	
			ART UNIT	PAPER NUMBER
			2812	

DATE MAILED: 09/27/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/657,505	Applicant(s) WU ET AL.	
	Examiner Scott Geyer	Art Unit 2812	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 27 July 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,2,5-15,18-24 and 52-56 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,2,5-15,18-24 and 52-56 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 08 September 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claim 56 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 56 recites the limitation "the first flowing step", "the first purging step", "the second flowing step" and "the second purging step" in lines 1-2. There is insufficient antecedent basis for this limitation in the claim. Further, the claim is currently dependent upon itself. The claim has not been treated further on its merits.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

Claims 1, 2, 10 and 11 are rejected under 35 U.S.C. 102(a) as being anticipated by Leu et al. (6,605,549 B2).

As to **claim 1**, Leu et al. teach an ALD process for forming a metal nitride layer on a patterned substrate. Specifically, Leu et al. teach a titanium nitride layer deposited using TDMAT and ammonia gaseous precursors. It is noted that since the process of Leu et al. is ALD (atomic layer deposition), Leu et al. teaches applicant's steps (b), (d), (f) and (g). See column 6, lines 30-59.

As to **claim 2**, Leu et al. teach the temperature to be 380 degrees Celsius and a pressure of 1 Torr.

As to **claim 10**, Leu et al. teach the metal nitride layer to have a thickness of 50-1000 Angstroms.

As to **claim 11**, Leu et al. teach an ALD process for forming a metal nitride layer on a patterned substrate. Specifically, Leu et al. teach a titanium nitride layer deposited using TDMAT and ammonia gaseous precursors. It is noted that since the process of Leu et al. is ALD (atomic layer deposition), Leu et al. teaches applicant's steps (b), (d), (f) and (g). See column 6, lines 30-59.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 5, 7 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Leu al. (6,605,549 B2).

As to **claim 5**: Leu et al. teach a metal precursor gas flowed into a chamber, but do not teach a flow rate of 500-10000 sccm for a period of 0.1-3 seconds; As to **claim 7**: Leu et al. teach nitrogen used as an inert gas purge, but do not teach a flow rate of 500-100000 sccm for a period of 0.1-10 seconds; As to **claim 8**: Leu et al. teach ammonia as the nitrogen reactant pulsed but do not teach a flow rate of 500-10000 sccm for a period of 0.1-3 seconds. The examiner notes that applicant does not teach that the flow rates and pulse times as claimed solve any stated problem or are for any particular purpose. Therefore, the flow rates and pulse times lack criticality in the claimed invention and therefore do not produce unexpected or novel results. It would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize the cited flow rates and pulse times because it is a matter of determining optimum process conditions by routine experimentation with a limited number of species of result effective variables. These claims are prima facie obvious without showing that the claimed ranges achieve unexpected results relative to the prior art range. In re Woodruff, 16 USPQ 2d 1935, 1937 (Fed. Cir. 1990). See also In re Huang, 40 USPQ 2d 1685, 1688 (Fed. Cir. 1996)(claimed ranges or a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. See also In re Boesch, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill or art) and In re Aller, 105

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USPQ 233 (CCPA 1995) (selection of optimum ranges within prior art general conditions is obvious).

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Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Leu al. (6,605,549 B2) as applied to claim 1 above, and further in view of Vaartstra (6,784,049 B2).

As to **claim 6**, Leu et al. teach a metal nitride ALD process as noted above for claim 1 but do not teach an inert gas used to transport a precursor gas into an ALD process chamber at a flow rate of 500-10000 sccm. However, Vaartstra teaches using an inert gas (such as nitrogen, helium and argon) used to transport a precursor gas, as noted in column 8, lines 35-44. It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method of Leu et al. with an inert gas transport as taught by Vaartstra so as to maintain proper flow of precursor gas into the process chamber. While Vaartstra does not teach the specified flow rate of 500-10000 sccm, the examiner notes that applicant does not teach that the flow rate as claimed solves any stated problem or is for any particular purpose. Therefore, the flow rate lacks criticality in the claimed invention and therefore does not produce unexpected or novel results. It would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize the cited flow rate because it is a matter of determining optimum process conditions by routine experimentation with a limited number of species of result effective variables. These claims are prima facie obvious without showing that the claimed ranges achieve unexpected results relative to the prior art range. In re

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Woodruff, 16 USPQ 2d 1935, 1937 (Fed. Cir. 1990). See also In re Huang, 40 USPQ 2d 1685, 1688 (Fed. Cir. 1996)(claimed ranges or a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. See also In re Boesch, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill or art) and In re Aller, 105 USPQ 233 (CCPA 1995) (selection of optimum ranges within prior art general conditions is obvious).

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Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Leu et al. (6,605,549 B2) as applied to claim 8 above, and further in view of Meng et al. (6,967,154 B2).

As to **claim 9**, Leu et al. teach a nitrogen reactant and a metal precursor reacting to form a metal nitride, as noted above for claims 1 and 8. Leu et al. do not teach a plasma to assist in the reaction between the two. However, Meng et al. teach an ALD process to deposit a metal nitride wherein plasma is used to assist the deposition (see abstract). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method of Leu et al. with a plasma assist as taught by Meng et al. to assist in dissociating the gas materials to enhance the reaction and deposition process.

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Claims 12, 13 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Leu et al. (6,605,549 B2) in view of Choi et al. (6,815,285 B2).

As to **claim 12**, Leu et al. is cited (as noted above for similar claim 1) for teaching an ALD process of forming titanium nitride, which is applicant's steps (a) through (g), including the use of TDMAT and ammonia as the source gas precursors for titanium and nitrogen. Leu et al. do not teach planarization of the metal nitride layer. However, Choi et al. teach a metal nitride deposition process utilizing ALD, wherein the metal nitride is planarized (see figures 10 and 11). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method of Leu et al. with planarization as taught by Choi et al. so as to provide for a method of removing unwanted and excess material.

As to **claim 13**, Leu et al. teach the dielectric layer being a low k dielectric layer and having a thickness of 500-50000 Angstroms. See column 8, lines 6-23.

As to **claim 15**, Leu et al. teach the temperature to be 380 degrees Celsius and a pressure of 1 Torr.

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Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Leu et al. (6,605,549 B2) in view of Choi et al. (6,815,285 B2).

As to **claim 14**, Leu et al. and Choi et al. teach a metal nitride ALD process as noted above for claim 12 to fill an opening (via), but do not teach wherein the opening (via) has a width of 100 nm or less. The examiner notes that applicant does not teach that the opening width as claimed solves any stated problem or is for any particular

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purpose. Therefore, the opening width lacks criticality in the claimed invention and therefore does not produce unexpected or novel results. It would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize the cited opening width because it is a matter of determining optimum process conditions by routine experimentation with a limited number of species of result effective variables. These claims are prima facie obvious without showing that the claimed ranges achieve unexpected results relative to the prior art range. In re Woodruff, 16 USPQ 2d 1935, 1937 (Fed. Cir. 1990). See also In re Huang, 40 USPQ 2d 1685, 1688 (Fed. Cir. 1996)(claimed ranges or a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. See also In re Boesch, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill or art) and In re Aller, 105 USPQ 233 (CCPA 1995) (selection of optimum ranges within prior art general conditions is obvious).

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Claims 18, 20 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Leu et al. (6,605,549 B2) in view of Choi et al. (6,815,285 B2).

As to **claim 18**: Leu et al. and Choi et al. teach a metal precursor gas flowed into a chamber as noted above for claim 12, but do not teach a flow rate of 500-10000 sccm for a period of 0.1-3 seconds; As to **claim 20**: Leu et al. and Choi et al. teach nitrogen used as an inert gas purge as noted above for claim 12, but do not teach a flow rate of 500-100000 sccm for a period of 0.1-10 seconds; As to **claim 21**: Leu et al. and Choi et

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al. teach ammonia as the nitrogen reactant pulsed as noted above for claim 12, but do not teach a flow rate of 500-10000 sccm for a period of 0.1-3 seconds. The examiner notes that applicant does not teach that the flow rates and pulse times as claimed solve any stated problem or are for any particular purpose. Therefore, the flow rates and pulse times lack criticality in the claimed invention and therefore do not produce unexpected or novel results. It would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize the cited flow rates and pulse times because it is a matter of determining optimum process conditions by routine experimentation with a limited number of species of result effective variables. These claims are prima facie obvious without showing that the claimed ranges achieve unexpected results relative to the prior art range. In re Woodruff, 16 USPQ 2d 1935, 1937 (Fed. Cir. 1990). See also In re Huang, 40 USPQ 2d 1685, 1688 (Fed. Cir. 1996)(claimed ranges or a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. See also In re Boesch, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill or art) and In re Aller, 105 USPQ 233 (CCPA 1995) (selection of optimum ranges within prior art general conditions is obvious).

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Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Leu al. (6,605,549 B2) and Choi et al. (6,815,285 B2) as applied to claim 12 above, and further in view of Vaartstra (6,784,049 B2).

As to **claim 19**, Leu et al. and Choi et al. teach a metal nitride ALD process as noted above for claim 1 but do not teach an inert gas used to transport a precursor gas into an ALD process chamber at a flow rate of 500-10000 sccm. However, Vaartstra teaches using an inert gas (such as nitrogen, helium and argon) used to transport a precursor gas, as noted in column 8, lines 35-44. It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method of Leu et al. and Choi et al. with an inert gas transport as taught by Vaartstra so as to maintain proper flow of precursor gas into the process chamber. While Vaartstra does not teach the specified flow rate of 500-10000 sccm, the examiner notes that applicant does not teach that the flow rate as claimed solves any stated problem or is for any particular purpose. Therefore, the flow rate lacks criticality in the claimed invention and therefore does not produce unexpected or novel results. It would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize the cited flow rate because it is a matter of determining optimum process conditions by routine experimentation with a limited number of species of result effective variables. These claims are prima facie obvious without showing that the claimed ranges achieve unexpected results relative to the prior art range. In re Woodruff, 16 USPQ 2d 1935, 1937 (Fed. Cir. 1990). See also In re Huang, 40 USPQ 2d 1685, 1688 (Fed. Cir. 1996)(claimed ranges or a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. See also In re Boesch, 205 USPQ 215 (CCPA) (discovery of optimum value of result

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effective variable in known process is ordinarily within skill or art) and In re Aller, 105 USPQ 233 (CCPA 1995) (selection of optimum ranges within prior art general conditions is obvious).

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Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Leu et al. (6,605,549 B2) and Choi et al. (6,815,285 B2) as applied to claim 21 above, and further in view of Meng et al. (6,967,154 B2).

As to **claim 22**, Leu et al. and Choi et al. teach a nitrogen reactant and a metal precursor reacting to form a metal nitride, as noted above for claims 1 and 8. Leu et al. and Choi et al. do not teach a plasma to assist in the reaction between the two. However, Meng et al. teach an ALD process to deposit a metal nitride wherein plasma is used to assist the deposition (see abstract). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method of Leu et al. and Choi et al. with a plasma assist as taught by Meng et al. to assist in dissociating the gas materials to enhance the reaction and deposition process.

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Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Leu et al. (6,605,549 B2) and Choi et al. (6,815,285 B2) as applied to claim 12 above, and further in view of Cao et al. (6,972,267 B2).

As to **claim 23**, Leu et al. and Choi et al. teach a method of metal nitride ALD as noted above for claim 12, but do not teach measuring a thickness of the metal nitride layer. However, Cao et al. teach measuring the thickness of a metal nitride layer (see

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figure 8, step 116 and column 7, line 15 et seq.). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method of Leu et al. and Choi et al. with a measurement step as taught by Cao et al. so as to stop the process as soon as a desired thickness is achieved which would prevent any unnecessary waste of materials being used to build the layer.

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Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Leu et al. (6,605,549 B2) and Choi et al. (6,815,285 B2) as applied to claim 12 above, and further in view of examiner's official notice.

As to **claim 24**, Leu et al. and Choi et al. teach a method of metal nitride ALD as noted above for claim 12, and Choi et al. further teach planarization of the metal nitride. However, Choi et al. does not specifically teach chemical mechanical polishing (CMP) to achieve the planarization. However, it is notoriously well known in the art of semiconductor manufacturing to use CMP to achieve a planar surface, and it would have been obvious to a person of ordinary skill in the art to use CMP to achieve a planar surface and to remove unwanted excess material.

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Claims 52-55 are rejected under 35 U.S.C. 103(a) as being unpatentable over Leu et al. (6,605,549 B2) in view of Choi et al. (6,815,285 B2).

As to **claim 52**, Leu et al. teach providing a substrate with a conductive layer within the substrate, formation of a dielectric layer atop the substrate and formation of an opening within the dielectric layer as shown in figures 4A-4C. Leu et al. further teach

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an ALD process to fill the opening with a titanium nitride material using TDMAT as a precursor for titanium. Leu et al. do not teach planarizing of the titanium nitride layer. However, Choi et al. teach a metal nitride deposition process utilizing ALD, wherein the metal nitride is planarized (see figures 10 and 11). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method of Leu et al. with planarization as taught by Choi et al. so as to provide for a method of removing unwanted and excess material.

As to **claims 53-55**, it is noted that both Leu et al. and Choi et al. teach an ALD process. Therefore, both Leu et al. and Choi et al. necessarily teach a plurality of metal nitride monolayers as recited in claim 53, each of the metal nitride layers comprising at least one metal and one nitrogen as recited in claim 54 and the purging processes as recited in claim 55, since the ALD process necessarily results in these limitations.

Response to Arguments

Applicant's arguments with respect to claims 1, 2, 5-15 and 18-24 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

The following reference is cited as being particularly relevant to the applicant's invention: Zheng (6,653,199 B2).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Scott Geyer whose telephone number is (571) 272-

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1958. The examiner can normally be reached on weekdays, between 10:00am - 6:30pm. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Lebentritt can be reached on (571) 272-1873. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

SBG
September 19, 2006

SCOTT B. GEYER
PRIMARY EXAMINER

SBG
9-19-06